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NOTES ON GEOGRAPHIC DISTRIBUTION

Novel finding of *Panstrongylus rufotuberculatus* (Champion, 1899) (Hemiptera, Reduviidae, Triatominae) in Belize, with a note on single Rhodnius Stål, 1859 species observations

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Abstract. We report Triatominae species *Panstrongylus rufotuberculatus* (Champion, 1899) for the first time in Belize. The specimen was collected in Cayo District, Belize in 2003 and later discovered in 2023 in a research collection. The distribution of *P. rufotuberculatus* spans Mexico to Argentina, and Belize lies within this range. This finding represents the fifth triatomine species reported in Belize, but only two species, *Triatoma dimidata* Latreille, 1811 and *T. mopan* Dorn et al., 2018, have been reported more than once. More research is needed to fully understand Triatominae biodiversity in Belize.

Key words. Central America, Chagas disease, disease vectors, Triatominae diversity, Triatomine bugs, *Trypanosoma cruzi*

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INTRODUCTION

Triatominae (Hemiptera, Reduviidae) is a subfamily of assassin bugs consisting of obligate blood feeders that are best known for their capacity to transmit the zoonotic protozoan parasite, *Trypanosoma cruzi* (Chagas, 1909), which causes Chagas disease. The biodiversity of the subfamily Triatominae is still being described; the current species count is 159 extant species and three fossil species, summing to 162 species spanning 18 genera (Alevi et al. 2021; Oliveira Correia et al. 2022; Zhao et al. 2023; Oliveira-Correia et al. 2024). The genus *Triatoma* Laporte, 1832 exhibits the highest species diversity (83 species), followed by *Rhodnius* Stål, 1859 (20 species; Zhao et al. 2021; Oliveira-Correia et al. 2024) and *Panstrongylus* Latreille, 1811 (17 species). The genus *Rhodnius* belongs to the tribe Rhodniini, while the genera *Triatoma* and *Panstrongylus* belong to the tribe Triatomini, which exhibits the broadest geographical distribution among Triatominae, spanning a wide array of ecotopes (Abad-Franch and Gurgel-Gonçalves 2021).

Central America is home to 18 triatomine bug species across seven genera: *Belminus* Stål, 1859; *Cavernicola* Barber, 1937; *Eratyrus* Stål, 1859; *Microtriatoma* Prosen & Martínez, 1952; *Panstrongylus*, *Rhodnius*, and *Triatoma*. Three species (*T. ryckmani* Zeledon & Ponce, 1972, *T. mopan* Dorn et al. 2018, and *B. santosmalletae* Dale, Justi & Galvão, 2021) have been found only in Central America, while three other species (*B. costaricensis* Herrer, Lent & Wygodzinsky 1954, *T. nitida* Usinger, 1939, and *T. huehuetenanguensis* Lima-Cordón et al. 2019) are found only in Central America and southern Mexico (Galvão et al. 2003; Dorn et al. 2018; Lima-Cordón et al. 2019). Since the elimination of *R. prolixus* Stål, 1959 from Central America, the species of highest epidemiological concern are *T. dimidiata* Latreille, 1811 and *R. pallescens* Barber, 1932 (mainly in Panama; Peterson et al. 2019a). Other triatomine species in Central America are emerging as possible secondary vectors of concern due to occasional intradomiciliary populations, including *T. ryckmani*, *T. nitida*, and *P. geniculatus* (Latreille, 1811) (reviewed by Peterson et al. 2019a, 2019b).

Situated on the southeastern corner of the Yucatan Peninsula bordering Guatemala and Mexico, Belize has 420,000 inhabitants (Central Intelligence Agency 2024), making it the least populous of the seven countries in Central America (Figure 1). Although Belize is one of the 21 nations considered to be Chagas-endemic by both the World Health Organization and Pan American Health Organization, in-country surveillance is minimal; triatomines are not under surveillance by the Belize Ministry of Health, and clinically

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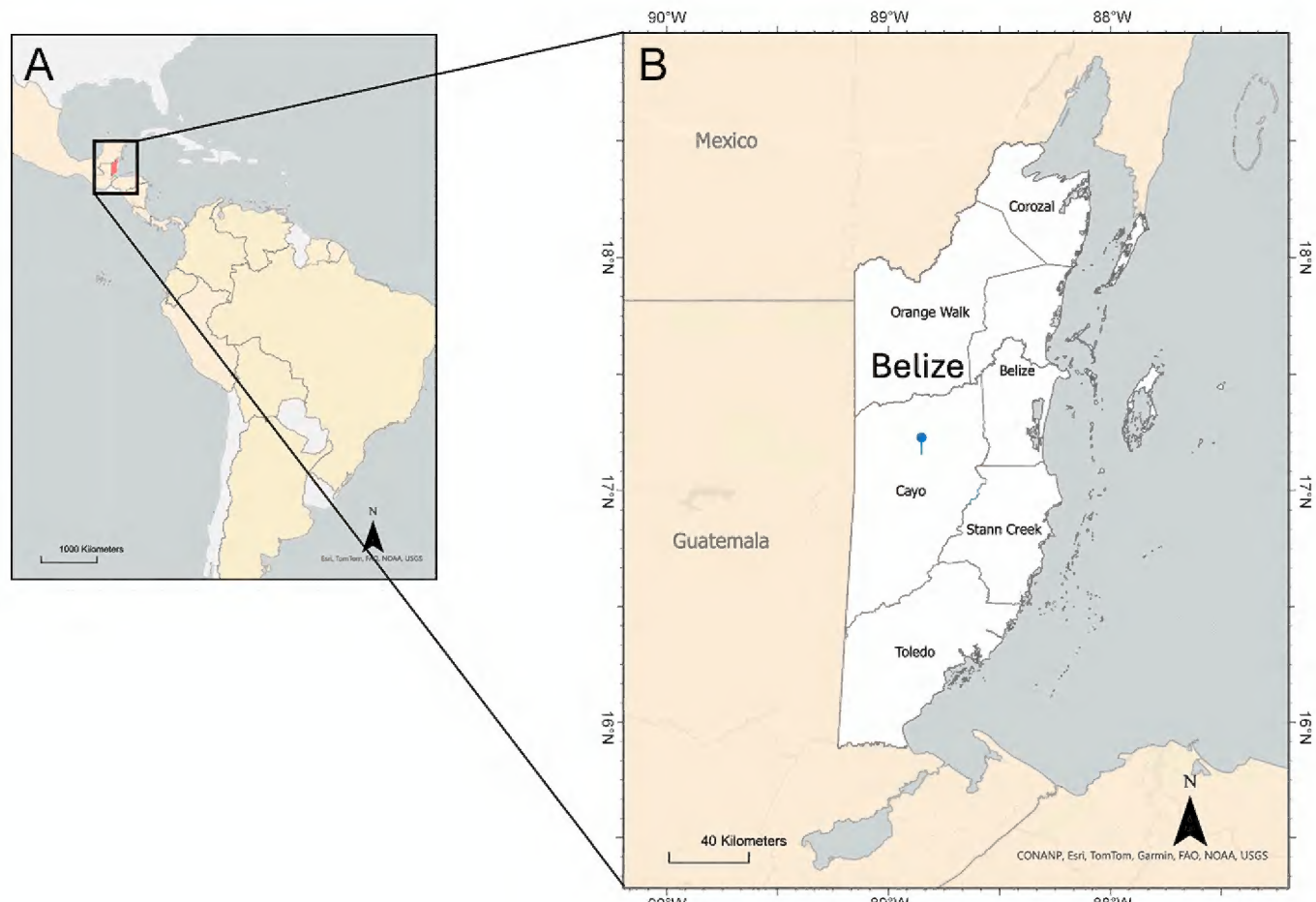

Figure 1. *Panstrongylus rufotuberculatus* distribution and location of specimen reported here. **A.** *Panstrongylus rufotuberculatus* distribution; beige colored countries indicate prior reports of the species; red indicates Belize, reported here for the first time. **B.** Belize magnified to display the collection location of the *P. rufotuberculatus* specimen, indicated by a blue pin. The six administrative districts of Belize (Belize, Cayo, Corozal, Orange Walk, Stann Creek, and Toledo) are indicated within Belize.

diagnosed cases are rare (Petana 1978; Polonio et al. 2009; Peterson et al. 2019a; Caranci et al. 2022). As such, the true risk of Chagas disease transmission in Belize is unknown (Caranci et al. 2022). Belize was the last country in Central America to discover endemic *T. cruzi* circulation; the nation was considered Chagas-free until 1964 when *T. cruzi* was discovered in a coati; the triatomine species *T. dimidiata* was discovered in the country shortly thereafter (Petana 1978).

As in neighboring Guatemala, *T. dimidiata* is the triatomine species most commonly encountered by humans in Belize (Caranci et al. 2022; reviewed by Peterson et al. 2019); until 2018, *T. dimidiata* was the only triatomine species in the country that was observed more than a single time (Petana 1978; Polonio et al. 2009; Caranci et al. 2022). *Rhodnius pallescens* and *R. pictipes* Stål, 1872 were reported in Belize one time each, in the early 1900s and 1931 (Lent and Wygodzinsky 1979), respectively, and their presence in the country needs confirmation. In 2018, Dorn et al. described a new triatomine species *T. mopan*, a cave-dwelling species found so far in Belize and Guatemala (Dorn et al. 2018). This species was the fourth triatomine species reported in Belize.

Panstrongylus rufotuberculatus (Champion, 1899) is primarily a sylvatic species that is distributed widely throughout Latin America from Mexico to Argentina (Galvão et al. 2003; Bérenger et al. 2009; Hiwat 2014). In Central America, the species has been reported in all countries except Belize and El Salvador (Maes 2002; Galvão et al. 2003; Secretaría de Salud and Gobierno de la Republica de Honduras 2018). The species is also found on the Caribbean islands of Trinidad and Tobago (Omah-Maharaj 1984). This extensive geographic distribution underscores the adaptability and dispersal capacity of *P. rufotuberculatus* across diverse habitats throughout the Americas (Rocha et al. 2021; Tineo-González et al. 2023).

METHODS

In 2003, an insect collecting expedition in Belize targeting auchenorrhynchous Hemiptera yielded an unidentified reduviid specimen. The specimen was collected from Teakettle Bank at the former Pooks Hill Lodge in Cayo District, Belize. Pooks Hill Lodge consisted of a few cabins of thatched-roof construction bordered by a 7000-acre nature reserve. The reserve consisted mainly of lowland or low hills (near Roaring River), forested with tropical moist broadleaf forests (Petén-Veracruz Moist Forest). More broadly, the vicinity contained a mosaic of forests with agriculture and grazing lands and low-density settlement.

Collecting techniques employed on the expedition included active collecting during the day and mercury-vapor or ultraviolet light collecting at night. The collecting technique that yielded the unidentified reduviid specimen was not recorded. Upon completion of the expedition, the specimen was deposited with other unclassified Hemiptera in the University of Delaware Insect Research Collection. In 2023 the specimen was rediscovered in the collection and identified down to the species level using the dichotomous keys found in Lent and Wygodzinsky (1979) and Carcavallo et al. (1998).

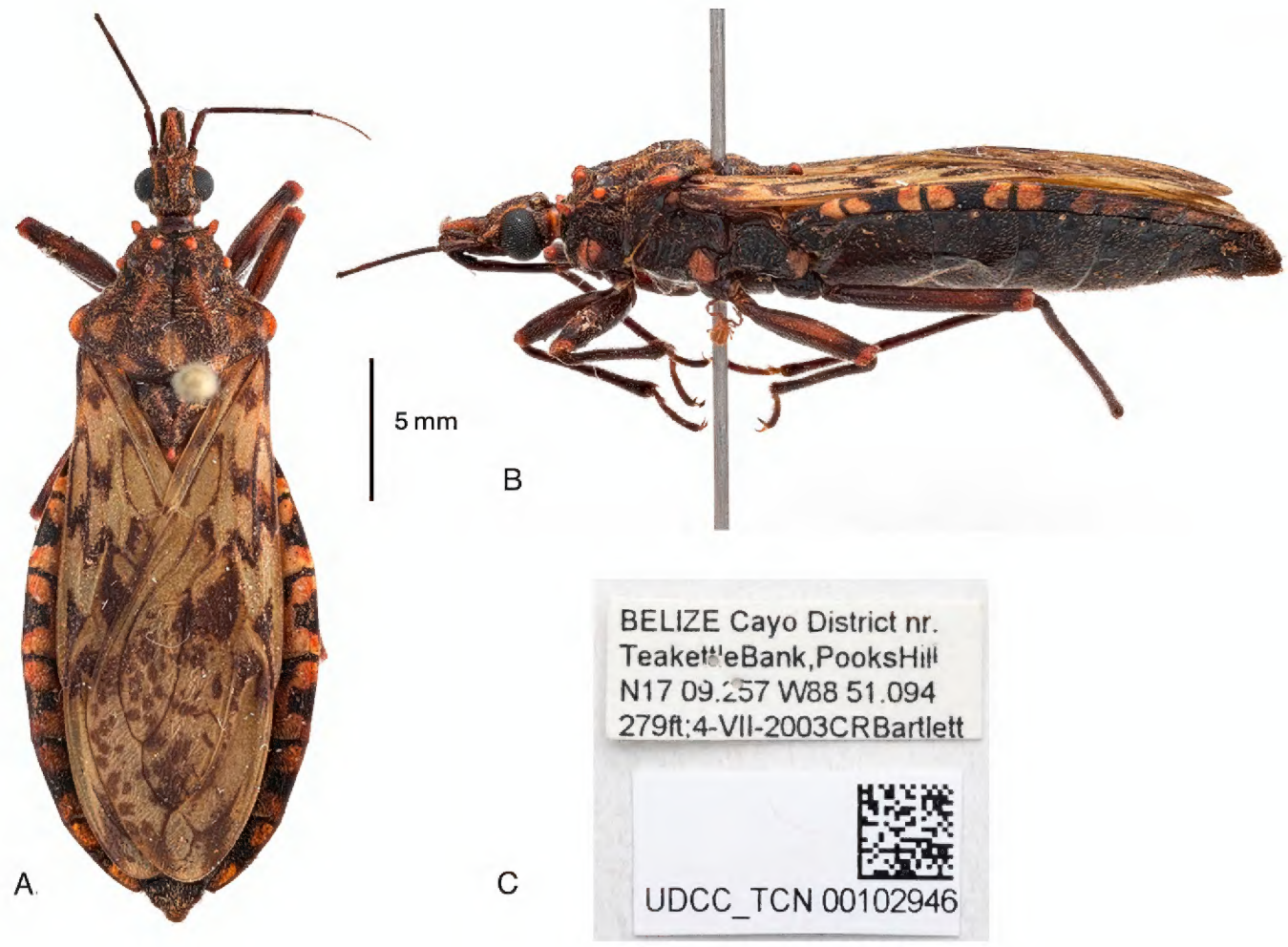

Figure 2. *Panstrongylus rufotuberculatus* specimen. A: Dorsal view. B: Lateral view. C: Specimen label, ID numbers and QR code.

RESULTS

***Panstrongylus rufotuberculatus* (Champion, 1899)**

New record. BELIZE – Cayo District • Pooks Hill, Teakettle Bank, former Pooks Hill Lodge; 17°09.257′N, 088°51.094′W; elev. 279 ft [85 m]; 4.VII.2003; Charles R. Bartlett leg.; collected near nature reserve consisting mainly of lowland or low hills, forested with tropical moist broadleaf forests; 1♀, pinned, University of Delaware Insect Research Collection UDCC_TCN 00102946.

Identification. The genus was identified based on subconical head shape, head shorter than pronotum, and antenniferous tubercles close to the front edge of the eyes. The species was determined based on the following characteristics: blunt jugae; reddish tubercles of the fore pronotal lobe; dorsal side of integument covered in adpressed golden setae; connexival segments with central dark markings and a narrow transverse dark band next to the front border of each segment; the overall color of the hemelytra is pale green with dark brown markings (Figure 2).

After species identification, the finding was reported to the Belize Ministry of Health Division of Vector Control, at which time they confirmed that *P. rufotuberculatus* had not previously been found in Belize (K. Bautista pers. comm.).

DISCUSSION

This finding expands the distribution of *Panstrongylus rufotuberculatus* (Champion, 1899) to include Belize, which is not surprising given that the species is present in neighboring Guatemala and Mexico (Figure 1). *Panstrongylus rufotuberculatus* in Belize is likely sylvatic and possibly active mainly at dusk, which could explain why it has not yet been reported in the country. Interestingly, this is the fourth triatomine bug species identification made in Belize based on a single specimen observed once, hinting at a wider Triatominae diversity in the country than is officially on record. The other single species descriptions consist of (i) a male *R. pictipes* collected in Benque Viejo, Belize in the early 1900s (Lent and Wygodzinsky 1979); (ii) a single specimen of *R. pallescens* collected in San Antonio, Belize in 1931 (Lent and Wygodzinsky 1979); and (iii) a *Eratyrus* sp. nymph found in 2022 in Cayo District, Belize. The specimen of *R. pictipes* is housed in the Hemiptera collection of the American Museum of Natural History in New York City, USA. We reviewed the specimen for the purposes of this manuscript and confirmed the species to be *R. pictipes* (photograph in Appendix Figure A1). The presence of *R. pictipes* in Belize is particularly intriguing considering that the species is otherwise confined to South America and the islands of Trinidad and Tobago. However, it should be kept in mind that the specimen was collected over 100 years ago and we do not know if *R. pictipes* is still present in Belize. There is also always the possibility of an old specimen being mislabeled, although we do not believe this to be the case here. The *R. pallescens* specimen is housed in the Essig Museum of Entomology Collection at the University of California at Berkeley (photograph found here: https://essigdb.

berkeley.edu/labels/1050000/EMEC1052852%20Rhodnius%20pallescens.jpg). The *Eratyrus* sp. nymph was identified through a photo posted on citizen science website inaturalist (https://www.inaturalist.org/observations/107375558). These single observations highlight the need for a thorough investigation of Triatominae diversity in Belize.

New reports of *P. rufotuberculatus* are ongoing (Omah-Maharaj 1984; Salomón et al. 1999; Avendaño-Rangel et al. 2014; Rocha et al. 2021; Souza et al. 2021), suggesting that the full geographic range of *P. rufotuberculatus* is still being described. The discovery of *P. rufotuberculatus* in new regions is likely exacerbated by deforestation and other habitat encroachment that has introduced artificial light into areas near *P. rufotuberculatus* habitat, as the species is known to be attracted to light (Salomón et al. 1999; Cuba Cuba et al. 2002; Castro et al. 2010). Additionally, it has been suggested that cryptic species exist within the *P. rufotuberculatus* populations (Pita et al. 2022), as illustrated by the recently described *P. noireaui* Gil-Santana et al., 2022 from Bolivia (Gil-Santana et al. 2022). *Panstrongylus noireaui* bears a striking morphological resemblance to *P. rufotuberculatus*, yet notable differences exist in its chromosomal and molecular characteristics. The description of *P. noireaui* highlights the importance of continuing investigations into the systematics and biodiversity of *P. rufotuberculatus* and other triatomine species with relatively large geographical distributions.

Finally, *P. rufotuberculatus* is considered an emerging or secondary vector species for *Trypanosoma cruzi* in parts of its range (Noireau et al. 1994; Wolff and Castillo 2002), and its presence in Belize, while is not cause for alarm, is epidemiologically noteworthy. The species has been found breeding inside rural homes in Colombia and Bolivia (Noireau et al. 1994; Wolff and Castillo 2002), in peridomestic areas of coastal Ecuador (Lazo 1985), and near artificial lights in Brazil, Argentina, and Peru (Salomón et al. 1999; Cuba Cuba et al. 2002; Castro et al. 2010). As deforestation and other habitat conversion continues to fragment forests and increase artificial light levels, which attract *P. rufotuberculatus* as well as other Triatominae, more research into the triatomine species in the region is merited from a public health perspective.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

Author contributions

Conceptualization: JKP. Data curation: JKP. Formal analysis: JKP, JO. Investigation: JKP, CRB JO. Methodology: JKP, CRB, JO. Visualization: JKP. Project administration: JKP. Writing – original draft: JKP, JO. Writing – review and editing: JKP, JO, CRB.

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Data availability

All data that support the findings of this study are available in the main text.

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APPENDIX

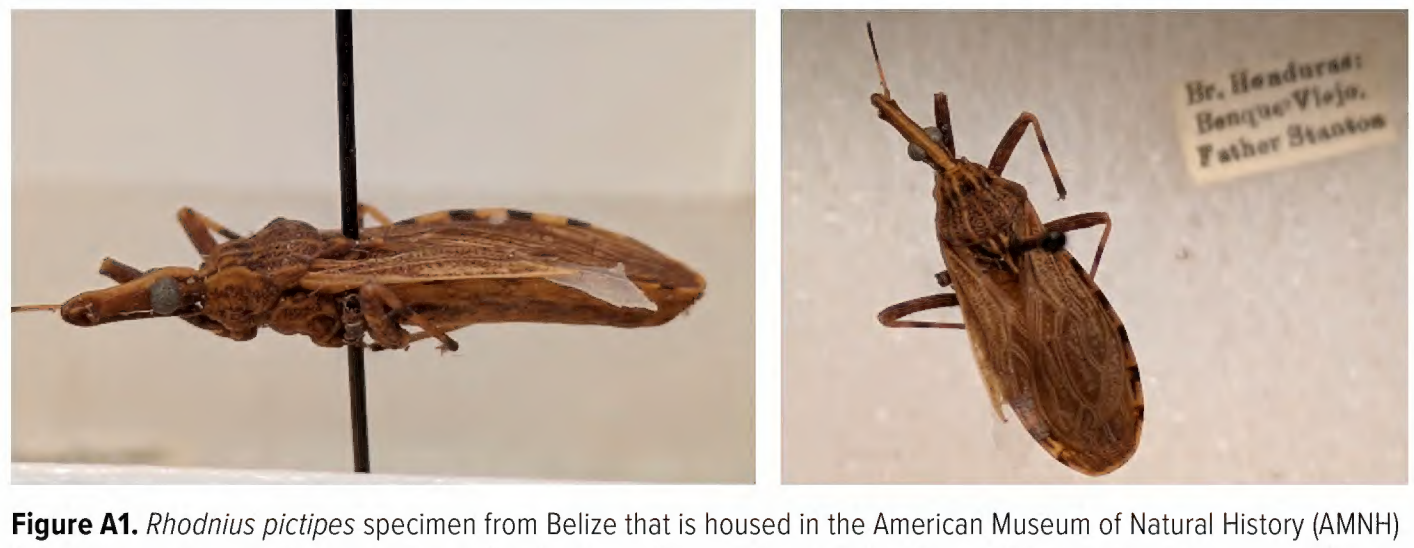

Figure A1. *Rhodnius pictipes* specimen from Belize that is housed in the American Museum of Natural History (AMNH) Reduviidae collection. The label reads: "Br. Honduras: Benque Viejo. Father Stanton." Father Stanton presumably refers to Williams A. "Buck" Stanton, a Jesuit missionary in Belize who collected insect specimens that are now housed in both the AMNH and the Smithsonian. The collection date of the specimen is unknown, but Father Stanton purportedly died in 1909, meaning that the specimen is at least 115 years old. Photos taken by J.K. Peterson.